Tonga - Samoa

H. S. Kelly

VIII.

BERNICE P. BISHOP MUSEUM

HONOLULU, HAWAII

FIELD NOTE BOOK

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FIELD NOTE BOOK

Subject Geology

Locality Tonga

Member of Staff H S Ladd

Date April 25 – 192 5.

Tongatapu
Muaia
Eua
13

Contents

Tongatabu - - - - - - - - - - - - 2
Eua - - - - - - - - - - - - - 6
Tongatabu - - - - - - - - - - - 48
Falcon - - - - - - - - - - - - 58
Tongatabu - - - - - - - - - - - 81
Lifuka - - - - - - - - - - - - - 87
Vavau - - - - - - - - - - - - 89
Upolu - - - - - - - - - - - - - 90

Montipora
Mussa
Acropora

13.

Tongatabu

Roll III Sh "Knight of St. Geo."

1 Wreck – off Tongatabu N.G
2 Fringing reef – Tongatabu (Nukualofa) N.G.
3 Wharf – Nukualofa N.G
4 } other near Levuka ? N.G
5 }

April 30, 1928.

T1. Nukualofa Quarry – 1¼ mi. SE square at Nukualofa. Quarry opened in one of low rounded hills that are found at several places on Tongatabu. Quarry face 40±' high & a considerable amount of rock has been taken out. Appears to be fairly good example of uplifted coral reef. Corals are very abundant, fairly well preserved, & many of the large heads are almost certainly in situ. Mollusc shells (usually as molds) are very abundant. Few echinoid spines, crown barnacles, bryozoa, forams, etc.

Roll III (14)
#6 road scene 1 mi± SE Nukualofa.
Roll IV #1 Nukualofa quarry, Tongatabu
April 30, 1928 (15)

The rock seems a very pure ls. No tuffaceous material appears. Weathers pure white or slightly cream colored. Zone of 2-3'± soil (residual?) caps ls. Rock is soft & friable on the whole.

Hoffmeister has identified following genera of corals:

Pocillopora
Stylophora
Orbicella
Fava
Meandra
Leptoria
Cyphastrea
Favites (?)
Goniastrea
Porites
Fungia
Montipora
Mussa
Acropora

Hoffmeister (1922) found one perfect echinoid but + one internal mold of brach.

Pelecypoda

Chama — very abundant
Arca
Tridacna gigas (Hoff. rec.)
Pecten (")
Cardium
Lithodomus — very abundant in coral heads
+ several others

Gastropoda —

Cypraea — 2 species at least
Oliva
Trochus
Turbo (cf. yellow operculum Fiji species Rec.)
Oliva ?
Natica ?
etc.

The island of Tongatabu is elongated from W to E., low lying + deeply embayed near center. No volcanic rock has been found on the island. Quakes are known to occur — perhaps brought by spring from coral rock below.

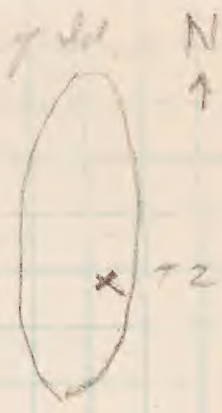
Nukualofa quarry is quite different from Waku Bay + Tamaua — which of all the Fijian localities most nearly resembled. Corals are far more abundant in Nukualofa quarry + heads average larger. No tuffaceous material or other impurities in Nukualofa L. Believe that Nukualofa fauna is more of a shallow water fauna — more corals, Cypraea, Chama, + Arca. Waku Bay contains more Natica, Pecten, etc. — few corals — smaller corals — from heads that seem to be in deep. Waku Bay is thinner + the coralliferous zone passes laterally into foram-ls. Several of the species collected at Nukualofa quarry (e.g. Turbo, Arca ?, Arca, closely resemble modern Fijian species. J. E. H. thinks

rock is probably Pleistocene. I suspect that molluscan fauna will equal or excel Waka-Bay in number of species. It certainly exceeds Waka-Bay in nos. of specimens.

#2 J. E. H. on launch - not feeling so well (16)
May 1, Tues

May 2. Wed. EUA

T 2 on 800' terrace. View of SE portion of Isl.



Terraces - eastern side

1) 100'
2) 200'
3) 340'
4) 400' - broadest except for
5) 500-600' - broadest
6) 760'
800' ridge

400' terrace + 360' terrace

placing men from T 2

T3 Vol. mat. - red sand & yellow bedded. ½ mi. N. Nipple tree. Yellow mat. bedded - red just below Vol. area just E. of ls. ridge 100 yds. from sea cliff. Yellow 3-4" thickness about horizontal. Red over & under. Maximum 60' vol. mat. between ls. in situ & base of sink (which is probably developed in underlying ls.

T3A II 3 View toward pinnacle from (17) top east ls. ridge. May 2. - looking NE.

(18) #4 Close up (5' - F6,8 @ 1/25 - cloudy) Parker's hill
Vol. breccia - variously colored & frag. up to 6" in diameter. General surface tan-colored. Badly weathered - fragments numerous - some resemble typical tonte. - undoubtedly land deposited - no bedding observable. - fragments variously colored. 100' ± from outcrop of lim. breccia.

Tuff with 18" dike. No foram or other fossils in tuff.
Nearly large block over 2' in diameter

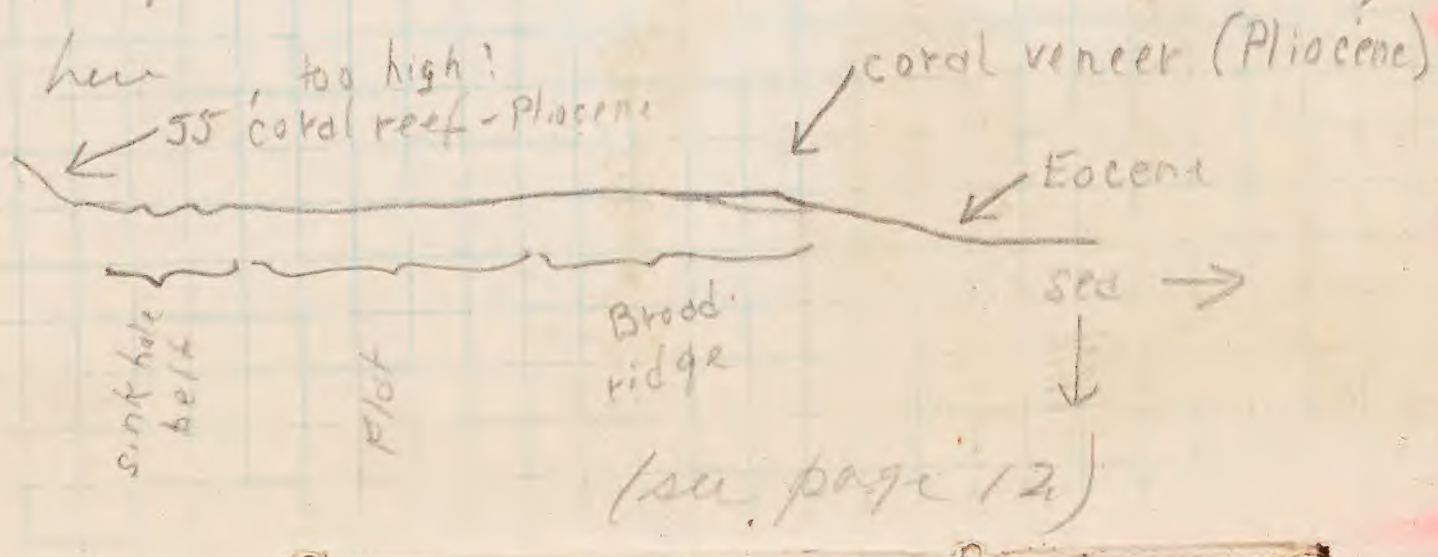
T4. Cliff at monument near Teamoa contact between vol. rock (below) & ls. above. Ls. cg. - cf. Koromiyama - Do these limestones carry into island?

May 2, thurs.
Aneroid at coral ls. in gully near South end 23.67 - 60' (aneroid broken)
T5 55' coral ls. exposed here. Corals make up at least ¼ of ls. - badly altered by recrystallization & solution in place & it is often impossible to recognize any organic structure with lens. Only a few foram & some branched structure that may be algae. A few very vol. pebbles badly weathered are abundant in crude bed. Well rounded, average 2" ± in diameter

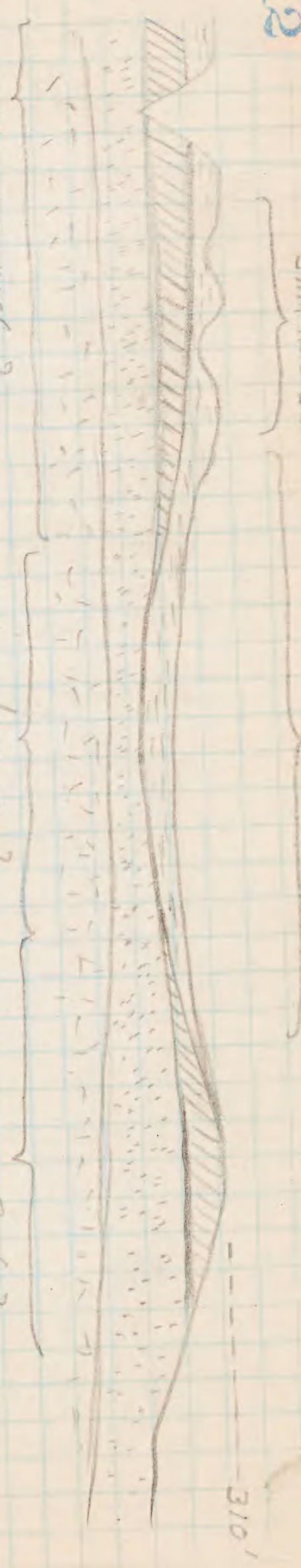
#5 (19) East of Tufu on Western ridge - view of flat above reef edge
#6 (20) Same - profile below ridge - ∨ about 15°.
Roll 5 #1 same loc. view of edge of reef (21) from side.

T6 Elevated coral reef. Rim of Pliocene? corals growing on Eocene ls. Latter contains Halimeda (algae) in abundance and forams. (Nummulites + Operculina, Orbitolites, coll. by J.E.H. nearly & id. by Galloway. - first 2 Eocene, 3rd Eocene or Oligocene). not morphic of EO,

Eocen Ls. is compact & relatively free from solution pits. No corals found in it. Coral veneer contains large no. of Acropora (like Rec-one) near edge. Ls outcrops numerous on slope - little erosion or talus deposition here.



(see page 12)



T7 Coast at Tufu - aneroid set at 0 at 23.77 (aneroid broken)

Examined modern fringing reef - algal reef - splended terraced lithothamnion ridge - 3'± above general level of pools are terrace cutter of algae reef 100± wide. Corals rare. Porolithon very abundant at actual edge of reef. Very porous ridge - blow holes. Elevated fringing reef at landward edge of present flat - much eroded by mechanical wear + sol pitting - very like Malagengen. General surface of old reef (now eroded) at about present high tide level. Maximum indentation of gorge at or slightly above highest tide. Above highest tide are 18' of elevated coral ls. of still older time

Pictures

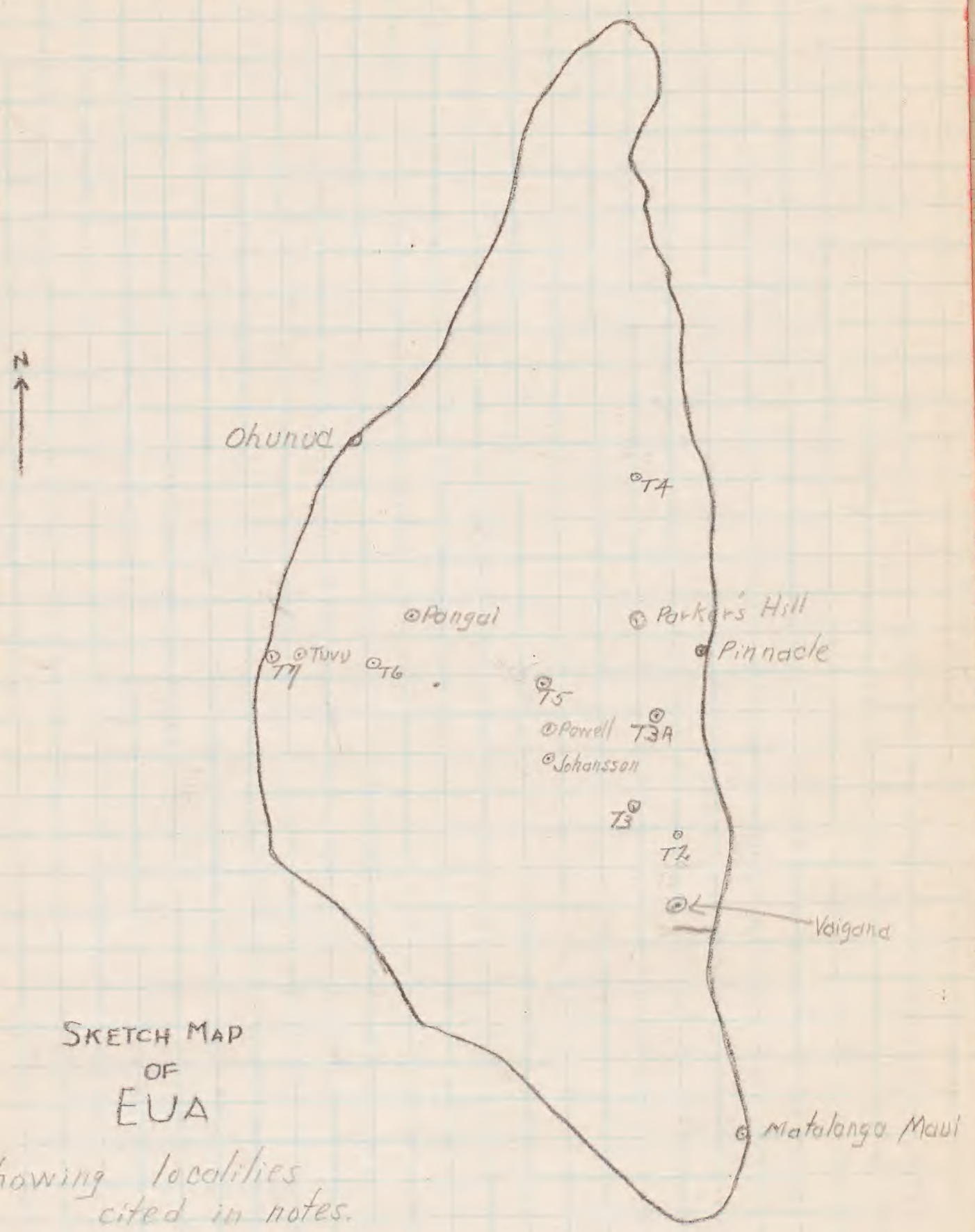
(22) " 2. lith ridge looking SW toward old fringing reef

(23) " 3 " " " NE approach dock

(24) " 4 gorge

Reef at Tuvu differs markedly from those near Suva. At Tuvu the reef is a true algal ridge with a well developed lithothamnion ridge. Corals & soft anemones are practically wanting. The whole mass is exceedingly porous with sea cave & spouting blow holes. S.E. H observed seaward edge closely & reported which mosses that might be coral growing below low tide level. Narrow ridges separate all pools behind main seaward terraced ridge.

LOCALITY MAP



SKETCH MAP
OF
EUA

Showing localities cited in notes.

1/2 inch = 1 nautical mile

Farmer

May 4th Friday.

25

26

28

(V.N.G)

N.G

May 5

#5 of EH

" 6

(29) & (30) - in negat. to know which is which

Pl. 7 = 1

(31) = 2 Stock

(32) 3 Stock (Van p. Lake)

May 6,

[illegible]

[illegible]

[illegible]

7

(33)

(34)

(35)

(36)

(37)

NG

8

Lodge
VIII
858

258

Ladd

VIII

1928

Table of stratigraphical Events B

Small scale of material on floor (or the higher portions of the island) and the relative to and other are not entirely clear. The materials in question are,

1) Volcanic breccia or agglomerate
2) Relatively fresh green-brown tuffaceous marl

3) Red sand
   a) bedded
   b) unbedded

6 Characteristics and Distribution

1) Volcanic breccia or agglomerate

A typical agglomerate. Angular blocks of variously colored lava fragments in a tuffaceous matrix. Quickly weathered. Usual surface tan or dark. Bedding obscure or wanting. Col of debris which likewise are weathered to soft clay. Typically exposed at Parkins Bay.

2) Green-brown tuffaceous marl.

Coarse to fine tuffs, well sorted, bedded with pronounced fossils, often very well jointed. Bedding planes regular. Dip at various angles, should be at many places. Never directly above it

3) Red sands

Deep red to yellow-brown in color, variously red. Quickly weathered. Tuff glassy and very regular. Seem to

in the sea bottom. Dark & [illegible] in parts abundant – little limestone contained in deposit like the [illegible] in Tonkinese. Building, when accessible, yellow sandstone of Amfoo. Regularly bedded in few places yellow sandstone beds containing what appear to be impressions of recent plants) are sometimes interbedded with red beds. Red beds are undoubtedly do not appear to be limited to any particular level. Well bedded type limited, so far as we know, to sink the area.

Tentative interpretation

It is believed that the agglomerates are a part of the original volcanic base of the island. Thus despite unknown conditions, the fact that they are [illegible] left [illegible] in the part that the underlie limestone (Permian) support this belief. The large size of some of the blocks (2'+) suggest that they were laid down near the vent. No volcanic fossils were found but this does not prove that it dropped into land down on land. Its rate of accumulation was probably rapid whether it was laid down on land or in sea.

It seems fairly certain that the fossil-bearing beds are a portion of the original volcanic base – which were therefore largely submarine. These beds may be seen directly underlying limestone but they were not found directly overlying it. They extend far just between Lang Son & Dong Dang & are about to be nearly vertical – due, it is thought, to faulting. Some faulting is clear for removal. The

to the point where it is easy to
see that such has been considerable
flow difference in the yielding from
the beginning of the
block partly accentuated only
slowly. Series of subsequent small
gravity slides of block tuffs which
could be recorded with solution
of calcareous tufa next to that.

Follow deposition of fresh tuffs
which found of the deposition (Eocene)
have to partly cover not, if not
all of subsequent bed.

Then are partially followed by
uplift with block faulting, certain
of the blocks being tilted at high
angles.

Subsequent erosion consisting
removal etc. to in many of the
higher areas and cut deeply

into the underlying tuffs. The
caps have remained in a few
places, protecting the underlying
soft tuffs and yielding small
conical hills.

It may be assumed that
certain of the faulted blocks were
considerably elevated. Much removed,
and deep erosion removed
much of the tuff after the faulting
to use dissolved. Then tuffs are
redeposited and again partly
etc. to and over the original
old cos. So valleys were partially
filled, and the general drainage
direction reversed with and sink
hole deposits and then better cover
with and soil also formed. In a
few of these regularly bedded stages
of lacustrine material & and
and now cut down. Subsidence
still remains. It should be

[illegible]

May 9. [illegible]

[illegible] 200' shaft in the small [illegible] longer in. Most were known as [illegible] holes. Bedded from 40 ft. [illegible] [illegible] [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

(45) [illegible] — Mrs Johnson — Ewa — May 1[illegible]

Roll 11 [illegible] 1–6 — pictures of Johnson [illegible]

(46) – (51) " " [illegible] on Johnson — May [illegible] 16

(Roll 12 [illegible] 1 & 2 — [illegible] — Schofield [illegible]

(52) (53) [illegible] — May 16, 1928)

May 2, 1928

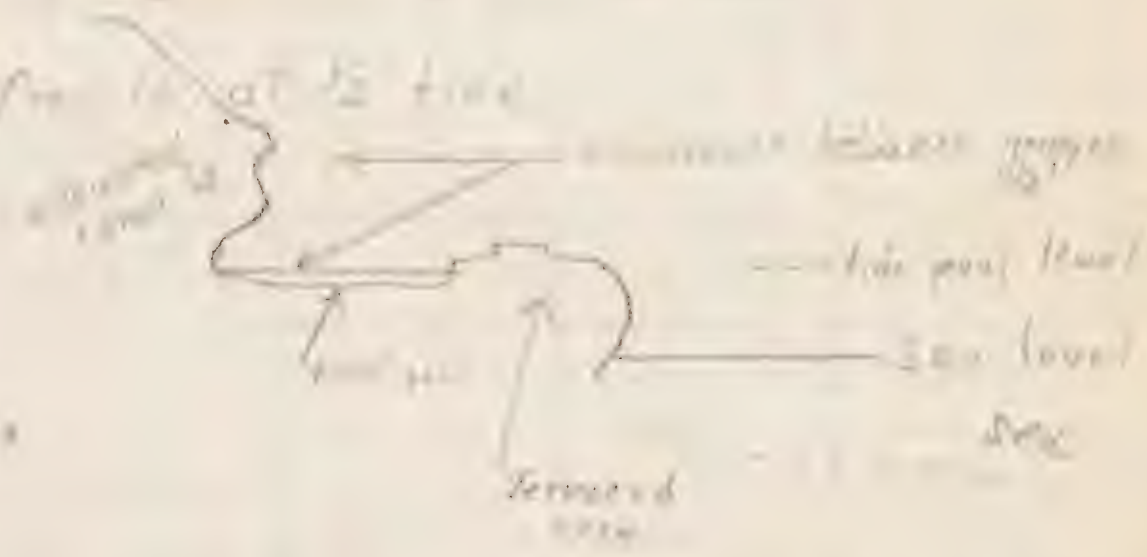
T18 Halawa — quarry Tanyatsu — see map & location. 30' breakfast do expand. Typical reef be very small to Nuhuwiloa quarry T1. Coral head very large & fat. Common [illegible] 5 inches exact estimate due to morphology [illegible] ½ to be sure — the [illegible] up to 2' in [illegible] of [illegible] [illegible] before [illegible] [illegible] structures. [illegible] [illegible] [illegible] may be edged [illegible] [illegible] ½ [illegible] on color surface of [illegible] often stained reddish or reddish brown. Fish very poisonous, [illegible] and looks quite recent.

Molluscs are quite abundant particularly boring bivalves (Lithodomus?). Some specimens of these are several inches in length and in such thick [illegible] [illegible] [illegible] occur through the [illegible] [illegible] present [illegible] [illegible] but in few specimens also present the [illegible] of the [illegible] [illegible] [illegible]

Wilson Creek – Continued

Wilson reef is beautifully developed – and marvelous tide-pools are well developed and reef covering about

For 1/2 at 1/2 tide



Scale 1 in. = 10

Seaward edge of reef is deeply undercut at below sea level at 1/2 tide. Crevices only – filled with channels & pools. Big waves – short water & height of 75' – spray even higher. Terraced zone 10–30' in width – widest & highest in re-entrants – narrowest & lowest on promontories. Terrace pools regularly shaped, well deep & gravelly, algae when water under, dirt, sea urchins

---

reef is strong & algae cannot grow out much but they grow up – building up the structure of successive terraces.

Tidal pool zone 30–100' wide. Tidal pools are flat. Terraced zone averaging 100' in width. Terraced zone nearly about 1/4 of this. Terraced zone varies from few inches to 2'½ above tidal pool. Lower 2–3' always at 1/2 tide. Seaward, there sandstone bottom which supports a growth of brown sea weed.

Zone of elevated coastline is deeply undercut at tide pools back. The gorge (lower gorge) is slowly being cut today at 1/2 tide seaward (wave damage & large fragmentation of rocks in tide pools – the rock seems to be pushed or cut up by heavily waves

[illegible] Today
[illegible] must not back
[illegible] friendly

[illegible] of. [illegible]
[illegible] when we stood
[illegible] [illegible] Elevated could be seen
12' above middle of the upper
[illegible] typical elevated coral
reef — many [illegible]

Immediately before [illegible] Island, the
[illegible] landed to — [illegible] coral beds.
Inland side of the old
reef — above upper [illegible]
[illegible] [illegible] [illegible] part of
the [illegible] many [illegible] than
[illegible] typical [illegible] [illegible]

of [illegible] heavy [illegible]
probably fill [illegible] of [illegible] [illegible].

T18 13 (58) View of [illegible] reef & cliff
Houfangalupe [illegible] from
top of cliff 175' high
— [illegible] [illegible] [illegible]

May 18. FRI
" 4 Hankam — [illegible] of reef
(59)

T19 [illegible] of [illegible] [illegible] from
[illegible] at Hankam
(60) #3 [illegible] (5') [illegible] of
[illegible] reef — [illegible]
[illegible]
[illegible] 15 [illegible]
[illegible] 1/3 [illegible]
[illegible] — [illegible]
[illegible] 12" [illegible]
[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Turbo sp. (common shell on living [illegible])
Trochus " of T. niloticus
Spondylus "
Tridacna " " of T. gigas
Cones sp. " cones

[illegible]

[illegible] Holothurians [illegible] [illegible] Beautiful coral [illegible] There [illegible] [illegible] on beach sand

(6) 4th 5 (see N.G.) Natural bridge - Hoffman's [illegible] [illegible] may make [illegible] [illegible]

Descended to see [illegible] of [illegible] bridge [illegible] through bridge with terrific [illegible] [illegible] [illegible] [illegible] to land to land the [illegible] [illegible] [illegible] [illegible]

[illegible]

[illegible] Lightly [illegible] [illegible] [illegible]

PRIBILOF ISLAND TRIP

Sun May 20

Left Unalaska early
at 5 aboard the cutter Etamako
(Military Stand) [illegible]
[illegible] Tech [illegible]
[illegible] early Saturday. The
Etamako is a stocky boat, 42 ft
ft long + 12½ ft beam. She is
decked over and carries berths
for 11 persons in addition. Forward
of these is a small compartment
for the crew. The engineers are
in Foster — there are 3
others in the crew. Our party
consists of nine persons: [illegible]

William Tangi, Chemist & Tog-
Frank Edwards - B.P.
C. S. Summers Coal Mining

W. A. Smith - mining engr etc
Ross-Murray - clerk prem.
J H D Spencer - B.P.
Cecil E. Wood - nodes
J. E. Hoffman det
H. J. Coff
Tangi [illegible]
B. Fox Leasing Module
Wood installed in [illegible]
[illegible]

Sailed out past wreck of
the "Knight of St. George" a steamer
that struck a reef 13-15 years
— loaded with lumber, etc. Place
NW for 1 miles. Removed of
coal been followed by
dinner of fresh cod, roast
beef & mutton, butter, jam,
pickles, tea. A little chop

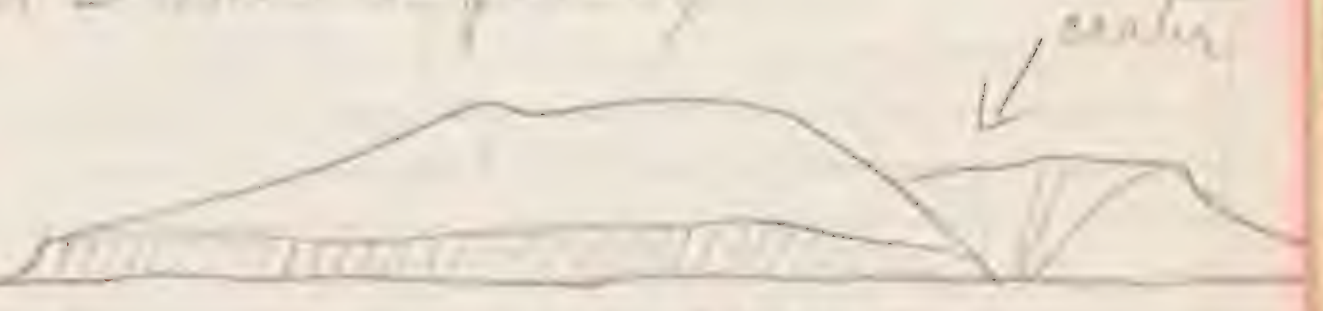
afternoon. The boat worked
well. Land in sight. Sail
as useful for Falcon is
only 45 miles away & we
are making about 5 knots.
Up midnight & rain again
on frequent. Phosphorescence
very beautiful. A cool wind
on deck but very stuffy below.
Wind on starboard of 8 pm
Wind 9 pm 100 passed two
small islands HORNE & TROUPE
closely enough off the port bow
We passed under lee of Fakaofo
& island inhabited. Land Falcon
We hove to on the south end
of the island & went daylight
Falcon appeared on an
almost perfect low cone
Rapids 5 miles or more
away but both very

clear. No land visible but
some smell felt on the air
Boat rolled heavily as she
lost momentum. On a
true slap sail, others are
sick. Beer & crackers for
thirst & we that want it

Stayed here to or 3 hrs
2-3 miles off shore.
Some birds about 6 pm
Sky partially cloudy. Sea
turns blue gray as light
strengthens after 9 pm to
a medium sky. The real
Solomon pale blue gray
cloud over Falcon & the
low gradually changing
into stern cloud with
itself appears yet black

Rock medium, brownish gray
behind & just above is, then a
belt of mossy pink & light blue
with reddish smoke gray band
behind in cliffs — more
cliff or exit higher than on east
bottom low flat on NW
& W. Crater appears to the SE
would be objected. Slope
gullied & rainwork. Crater
off — any [illegible] small
snow seems to be lying
heavily concealed [illegible]

[illegible] mass of
[illegible] from crater [illegible]
at head make [illegible] level
— probably gray [illegible] band
of lower slope & dreary looking
place side of gullies light
colored — bottom dark. Steep
drifting up several hundred
feet on the [illegible]



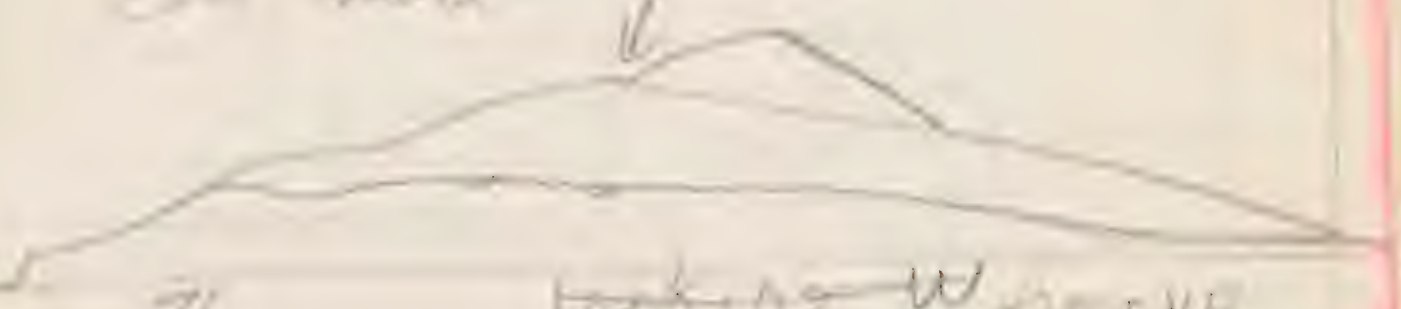
[illegible] [illegible] from
[illegible] of crater [illegible] [illegible] [illegible]
& drifting up to [illegible] for
hill top. Cliffs are 70' high
& appear unbroken [illegible] [illegible]
other side of crater cliff [illegible]
[illegible] 125' high

[illegible] Quartz [illegible] pr
Lead Sulphur [illegible]
[illegible] Copper Much [illegible] Iron
[illegible] Coal [illegible] south
Mal of [illegible] from water
[illegible] into [illegible] from
center. NW end of cavern
[illegible] 1 [illegible] Porous [illegible]
[illegible] [illegible] [illegible] Land
slide on SW side As [illegible]
[illegible] small cave with [illegible]
[illegible]

1200 X 15 = 18 = X 6 = 2

(69) view of cache from
(70) Mat. Geog. S. ½ mi ± off shore

East side of cache



looking W from ENE

cliff cabled horizontally x
gullied 90° back at high-
point. Bandet shadow of brown
Gullies 15-20' deep - typically
V-shaped

Rel 16 #1-2-3 panorama from
N.G. chart

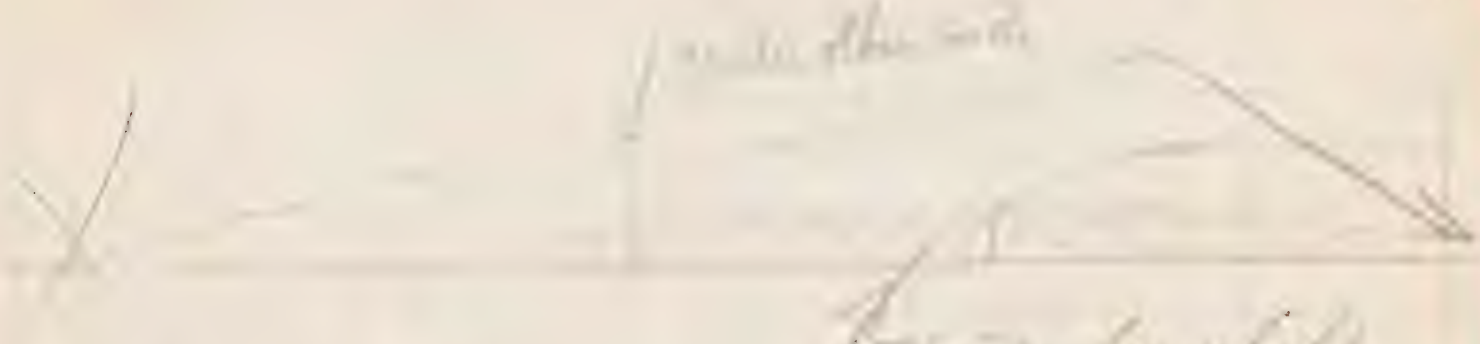
#4 view from NE - lately SE & S
Mollard sub low & flat
+5 mi N Hiking SW

(71-73 2 views)

Can see Horja tempt.
Horja Hagen to 2 SW. Divers
shot at Tanks along E side

Green water.

#6 another view from NE
+5 at ½50 - filter - 7 AM



from NNE

Flat-low cliff

Offshore [illegible] stay on
we [illegible] to mid off the
Reef heavily broken with [illegible]
stuff

N W side steep cliffed with
heavy surf

Rel 6 #1 view of NW cliff
[illegible]

17 (74)

(75) (76) (77)

18 (78) 1 crater looking E x S W

Observations from logical point on east side of crater. Elev ~~1600~~ 200

Wall varies from 5 to 10 ft
2 fronts between is reversed &
tilted only under 20 deg &
at north end of western side is
[illegible] feet high marked by
ridge near second edge
Inside the crater sides yellow
near with sulphur - white & yellow
or yellow. Entering it the
crater sides are of lavas
& deposition - yellow & orange
colored. There seem one or
lower part of outer walls &
where E side dip 55° &
are deeply fluted with strong
yellow ridges. Inner slope
(or dip) is steeper (70°)
& uniformly fluted
from the top to the
rim except minor slides
rocks where it has dropped

Lake - yellow stain. Southern
part of inner crater separate
from outer crater by deep
narrow gully 30' deep in
deepest part - a member of
terminating gullies run up rock
(outer side) of inner crater at
western end. Eastern end of
crater has broad bowled summit
& steep inner face. Lake is
at sea level. Very muddy
with sulphur. Greenish at
second edge & very pale yellow
green at north end. Lake is
4/5 mile long & half as wide
at widest point (mean size)
Cliff above about to 3 hundred
at least 1/4 mile.
Floor of crater edge
crater is broad sulphur or mud
flat - shape of steamer here

and flat

Entire mass dotted with numerous ed. stubs of lava & agglomerate – some over 2 feet – diameter

Pl. 18 #2, 3, 4, 5 Panorama from Summit last side crater – Some blocks of agg. are over 4' in diameter. Block rarely less than 3'

(79A-B) (82) (83)

Sides entering lake have built small cliff of cinder & ash with concentric shards

Ascended to floor of crater from down gully in east wall – flat floor only reached at highest tide or time of storm. Very flat – scattered lava blocks – scoria – pumice & sulphur balls the size of peas. Flat floor comes off like wheel hub towards lessing steam jets here & there – at end of point that projects into the lake are boiling violently. One one entering jets without steaming – other area – large & only one – then. Bring up black sediment from below. Heavy sulphur deposit on base of east crater wall.

Pl. 8 #C (82) – Boiling lake

Heavy deposit of pumice at high tide mark, lake must be at sea level.

(83) 19 # # 1 Bays in crater flat

(84) # 2 Summer site holding bowl

Slope of summit of crater estimated at 300'

↑

Heavy blocks concentrated on outer edge for cliff around by wind & weather

Continue to all along summit & outer edge, as not

gorge

Excellent illustration of gullying & landslides and erosion

Gully separating inner & outer cone filled with recorded stuff drop down gully with gradient of valley - three seconds deposits have been blended

19 #3 Looking south from base of cone in outer crater - cutting at sea

Mouth of crater slope in gullies to sea - some well developed gully system on this side cone - good on lower summit - flat bottom slope in

Turns at summit of left

right

NE ¼ - double drift

flow

flow - 1 ½ - Eve - 1 day

Pattern of debris on reef flat

(see illustrated notes p. 86)

14 (86) ⅞ ⅛ - N.W. cliffs

N.E. = 5 N " ad 4s

N.L. - [illegible]

Many frag. of coralline algae, shells, stones. Large pools are cut into rock & filled with. On back reef - see [illegible] growing. Surprised [illegible] debris in rent up along shore - longest case which holds [illegible] opening (8" across), fragments of sea urchin glass, Nautilus egg case, bits of sea weed, etc.

Sandy area [illegible] dull. Fotunate in tiny stingy. Surf heavy against storm beach, [illegible] 15 yds. then broken. Tongue pools to land camera pools, & [illegible] reach thing to. Tongue leaves at to congregation on shore & it falls in water - finally received - completely washed! Land camera with

Tugs shot the [illegible]
[illegible] carefully [illegible] lead
in shot in the [illegible] of the
[illegible] [illegible] came [illegible] the
[illegible] [illegible] [illegible] against
heavy [illegible] [illegible] [illegible] &
[illegible] Tugs [illegible] [illegible] [illegible]
through our shot sleeve — our
[illegible] [illegible] [illegible] painfully

Returning to Pelusiaks Tugs
cable came & [illegible]
removed on his back successfully.
We [illegible] but start 12:20,
having spent nearly 5 hours
ashore

Began towing back to
Nebulofa — arriving next morning
about 10:30 AM

May 2 [illegible]

Harmonya Galley at
[illegible]
[illegible]

[illegible]

[illegible]

[illegible]

prominent, numerous colonies growing in
few little pools. Heads of Porites seen
sporadically on entire flat. Cladocora
is locally abundant especially in
zone 100-200' south edge of reef. Tide
coming in at edge of reef could not
be measured carefully. It rose abruptly
4 feet after 7:00 at a depth
underneath. Between 7 & 8:00 Tyrrel Lagoon
was almost mere edge & a number
of other green areas. Water not
conspicuous - Measure of a fathom
only. The reef does not appear
as strong south or east Barrier reef.
Suva

Exceedingly large numerous forams
with corrugated edges are very abundant
a little out & very out from shore. Bottom
of small space & small space &
outwards are numerous on inner half of
reef. Coming later on blue bottom

as common on inner edge. Holothuria
apparently not numerous though they are
not too for careful collecting. Cypraea
common.

Left on inner part of reef on
much like rounded 'cliff' of lava rock
- grayish green - showing blow the dark
color must be due to decomposing
organic matter for on cliffs or
similar rocks are exposed. It
has strength for days

Total depth not measured
but where found are quite large
several feet deep at low tide. They are
often almost filled with growing coral.
Collected Lithothamnion near lowest
edge of reef - quite a common form
here

Returning we visited 'Gun Hill' on
some considerable elevated hill SW of
Suva. Height about 475' - top about 90 460
(. above in level 60 ±)

Crater [illegible] [illegible] account – seen identified with [illegible] expected. [illegible] [illegible] or [illegible] and [illegible] island.

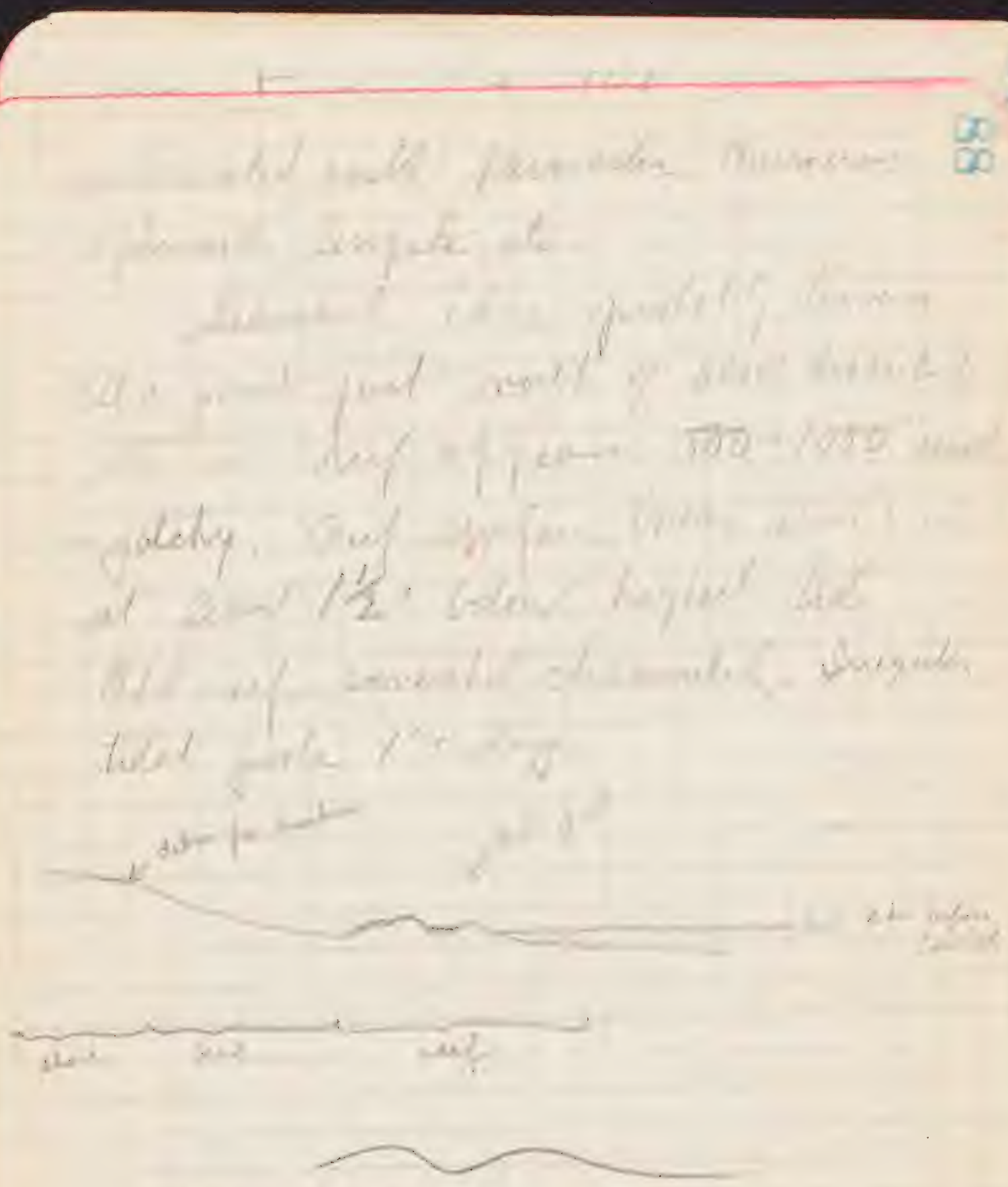
Additional notes on Halcon Del while passing on T.S.S. Tofua May 28 – Mon

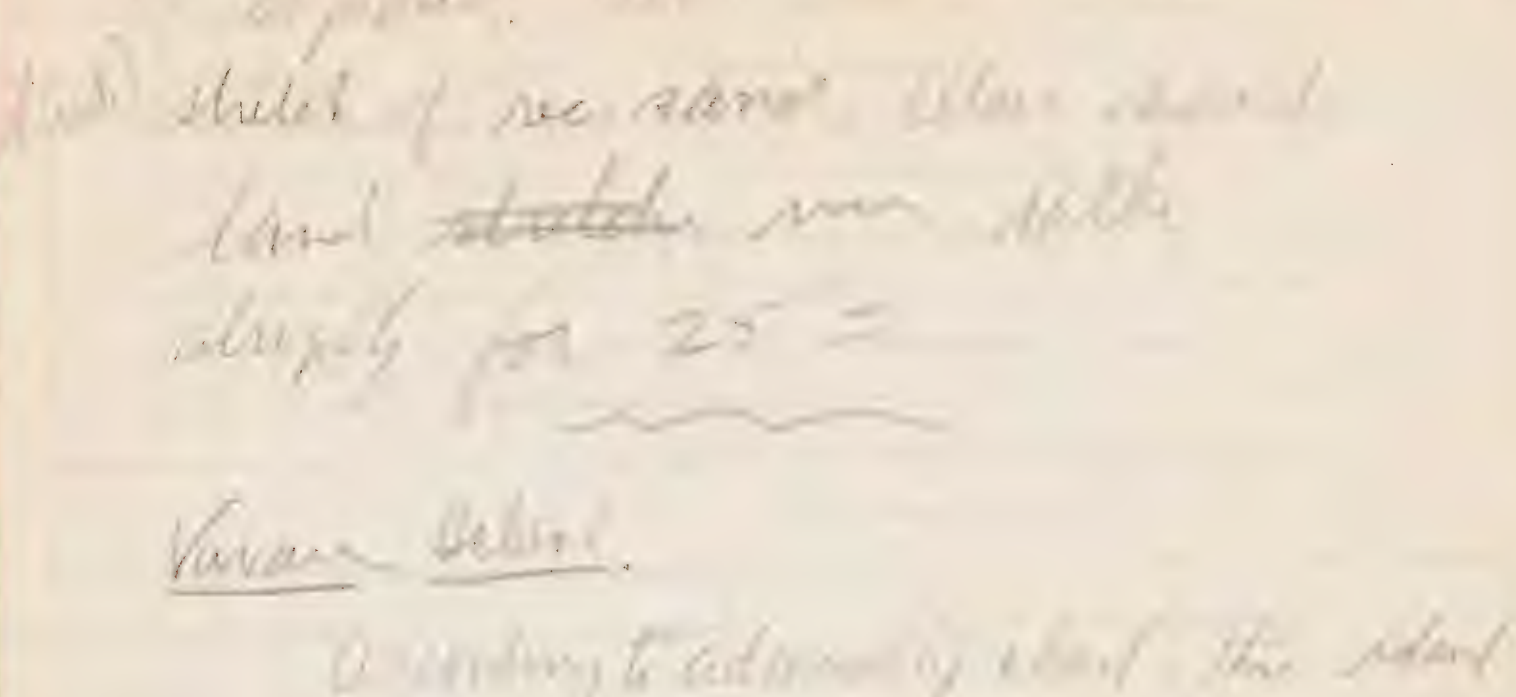
Crater lake on Sorol east side with [illegible] Tue. 5.
South side cliffed
Pilot's contour map 45°
Ash to floor crater on SE

– Viewing SE side the left crater wall facing sea is very steep
Right crater wall facing sea is cliffed. SE left crater wall partly cliffed
– SE shore not absolutely straight – bulges out slightly at crater extremes.

[illegible]

[illegible]





Varian Island.

According to admiralty chart the island is about 306 feet general elevation & slightly less than 1/8 (3125 ft). It is connected on that "Lake" (cliff [illegible]) & on seaward (NW) with than on landward SE). So from point of island towards [illegible] of [illegible] [illegible] Dangerous [illegible] [illegible] [illegible] [illegible] 25 =

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The [illegible] of the island [illegible] [illegible] [illegible] [illegible]

[illegible] very [illegible]
[illegible] [illegible] [illegible] [illegible]
[illegible] [illegible] [illegible] for 50 to
[illegible] [illegible] [illegible] [illegible] [illegible]
[illegible] [illegible] [illegible] [illegible] [illegible]
[illegible] [illegible] [illegible] [illegible] [illegible]

[illegible] surface — [illegible] very short to surface — [illegible] the [illegible] 3 [illegible] — a big for the commonest species — then rare to be second species. Polymorphism of other genera for a scattered. Polyps and tends to surface in pitted narrow strides of peak and basin, often covered and a few of soft anemones. The pitted surface seems to be Labrophyrinoa but I am not sure that these algae are living. Naturally large Acropora colonies exceed two feet in greatest diameter, most stems are less than 1'. The common species has a short stumpy branch. The long-branching blue-tipped form not seen. A few soft anemones.

Here [illegible] very slightly elevated above most zone & landward. [illegible]

[illegible] are [illegible]

Acropora zone.

2) Submarginal zone — — — — — — 60'

Acropora still the dominant genus of coral but colonies are becoming more scattered. Soft anemones more abundant, locally covering ¾ of reef-floored surface. Slightly lower than marginal zone. Acropora [illegible] project out of water that constantly [illegible] from Black Rock [illegible] numerous. He says water [illegible] large flocks of dead coral. The number of colonies of living coral gradually decreases as we go landward until at edge of submarginal zone they are very few & widely scattered.

3) Muggin Island Zone — — — — — 150'

This zone — dotted, and in places actually carpet, with large [illegible] colonies from seaward edge of [illegible] and [illegible] colonies. The water

are flattened and water-lain has produced a rough shingled effect. The fine colonies dipping at an angle of 45° to the sea. Some of the upper beds show signs of greater dynamic disturbance, colonies broken & scattered. Shelly rubble. The general surface of the area is fairly regular. The plane of most gives a slippery appearance & probably all small or dead. Small tidal pools & low depressions contain a great deal of much water-rubble. A few small fish in pools. The tide seems to be turning & the rocks are covered by 6"–1' of water.

As we proceed landward the large Mytilus decrease in size & number & the small debris increases in amount. At the ~~[illegible]~~ landward edge the surface is entirely covered with debris & a gray flaky seaweed (Halimeda?) is abundant. Bushes & encrusted Acropora stems cover a fine sandy debris of dead Halimeda?, etc.

4) Rubble bank ------336'

Acropora ~~stems~~ branches and fine debris piled well above low water. A few colonies are entire but most of the material is fragmentary. Nerinea occur in small gastropod shells occur by the hundreds near the landward edge of the zone. Black foraminifera are numerous near the seaward edge. The top of the bank is fairly level but there are low depressions filled with 6"–1' of water.

5) Eroded-rubble zone ------490'

These are [illegible] reserve of the coral heads are pebbles with scattered boulders (the exception is the common variety with the white-tipped spines). (Secondary colonies of flowing) Porites, and Porites and the [illegible] reef flat [illegible] sandy debris. Zone covered by water 1' at seaward edge + 6" at landward edge.)

6) Sand, weed, + rubble ------ 1185'

Entire zone covered by water at low tide - 2' at seaward edge to 3' at landward edge. Surface of bottom slightly undulating but not rough. Coral heads (living) + echinoids few. Mud free debris and a few large heads of dead coral. Character of bottom varies but little over entire zone. The debris is similar to that on Barrier West - Sum zone order, a channel too deep to walk - [illegible] narrow - about ½ mile + away

Cupid, Upolu, Western Samoa
May 31 - June 1, 1928

Section running S10E to N10W across reef east of harbor from point N20E of Catholic church (with double aquatrans) - starting point is N5E of summit of high hill near church.

Summary

1) Channel Marginal zone ------ 85'
2) Broad Acropora zone
   a) flat Acropora ------ 60'
   b) branching " ------ 120'
3) Trigger head zone ---------- 150'
4) Rubble zone ---------- 120'
5) Coral zone ---------- 120'
6) Lagoon ---------- 2000'±

Total to landward edge of lagoon 2655'±

Detailed Description

1) Channel zone ---------- 85'

Appears to be in a very healthy condition - better than any former coral zone I have seen. Large, slightly

Coral Gardens of Madagascar (as opposed to Fiji, Samoa, etc. common) the corals are dominated by branched gray Acroporas, like Cyphons, Staghorn and Montastrea brain corals. Among corals of this type, you see few other invertebrates besides Linckia. Coral sand & fragments & coral debris are the predominant substrate of the lagoon. The lagoon is not very deep (due to tropical evaporation causes) & the water is very clear & pleasant. There are a few scattered patches of Sargassum & Halimeda.

The reef is very steep — if not actually overhanging. The seaward edge of the reef has a jagged pattern as seen from above. When the bottom can be seen it appears white with darker patches irregularly distributed. In calm and tide low, but sea back heavily on the marginal zone and it is covered with water most of the time.

The Acropora has no very short stalkings branches, in a belt 8' wide + along the edge of the reef being coral seems to cover 90% of the surface for some distance at least. One is able to look downward over the steep seaward edge of the reef. There are no blow holes — the sea work

is often several fathoms deep so that the seaward front of the reef is very steep — if not actually overhanging. The seaward edge of the reef has a jagged pattern as seen from above. Where the bottom can be seen it appears white with darker patches irregularly distributed. In calm and tide low, but sea back heavily on the marginal zone and it is covered with water most of the time.

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dead & "moss" covered (there are a few living Porites & rarely a small colony of living Acropora). Nigger heads & finer debris begin to appear & dead Acropora (in situ) begin to disappear near landward edge.

3) Nigger head zone - - - - - - 150'

"Moss" covered blocks and flat dead colonies (somewhat shingled). Much debris of all sizes & shapes. Sandy material increasing to landward. Eight inches of water at landward edge. Many holothurians, few Porites & other corals, Tridacna & other mollusca.

4) Rubble zone - - - - - - - 120'

Very similar to #3 but no nuggerheads. Zone covered by 1' of water. Bottom covered by unassorted debris (but no large heads 2' or more)

5) Coral zone - - - - - - - - - - 120'

Numerous colonies of

101

92100

dominantly are the tops of the reef, but occasional patches of open "moss" bottom are still clearly connected in places. All extensive highly cemented in places.

Zone #1 the one has plenty of open "moss" bottom. The coral appears in the index-channel area near the landward margin of the zone - having coral fragments around the channels, however.

2) Broad Acropora zone

a) flat Acropora - - - - - - 60'

Broad coral areas 75% ± 4 meters deep (living?) in between and made apparently rather dead recently - have not been broken very much.

b) Branching Acropora zone - - - 120'

Extensive areas of 4" ± diam branches - all

the bottom ~~shelves~~ slope off to deep lagoon - bottom of lagoon much like Tyone 5 but apparently has more debri & less living coral. In passing over lagoon at low tide in boat the white patches of the bottom can be faintly made out now & then — must be at least 3-4 fathoms deep.

Lagoon is at least ½ mile broad. One can wade ashore near harbor entrance (to west). To east lagoon continues for some distance but beyond this shallow water extends nearly (if not entirely) all way from shore to outer reef. Lagoon probably local & hence outer reef ~~[illegible]~~ had best not be ~~hardly be~~ called a true barrier reef. Lagoon filled with fish - many quite large.

Olsen-Tyri Harbour and anchorage and with a shelf-like growth from reef with extensive patches, shallow, very rocky, bottom. Water 2' deep/dry at low tide. Bottom of the cove 4 3' deep over much of the cove & of barrier reef. Bottom between reef and beach covered with innumerable [illegible] of [illegible] 4.

6) Tyone:

at barrier reef opposite

Left line of section + + detoured around western edge of lagoon toward shore. Zone of living coral continues around lagoon edge. Some of the Porites masses are 8' in diameter. Several ~~specimens~~ specimen of Acropora, Meandra, etc. Side of lagoon rather steep. Few corals seem to grow below edge of lagoon. Schools of fish everywhere — a beautiful sight.

Dead coral increases as shore is approached. Lithothamnion nodules are common in debris. All coral fragments look algae-covered. Locally at a point 1/4 mile from shore there are thousands of white-tipped echinoids in dead Acropora.

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